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Procedural error in endodontics: A clinical review

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Abstract
Endodontic therapy consists of a series of scientifically based technical procedures. Lack of scientific knowledge, its poor application, or a compromise or a break in the chain of proper measures can lead to a number of accidents which are collectively called 'endodontic mishaps'. These accidents can occur during diagnosis, access preparation, cleaning and shaping, obturation and post-space preparation. Thus, the aim of present review of literature is to discuss endodontics procedural errors in details.

Keywords: root canal therapy, endodontics, endodontic mishaps

Introduction

The goal of root canal shaping procedures is to treat apical periodontitis through the removal of infected dentine from root canal walls [1]. Endodontics is the branch to maintain the natural integrity of the teeth by removing the microbial flora and cleaning of the root canals either by surgically or non-surgical root canal treatment followed by the restoration of the teeth [2]. The term success or failures in endodontics must be defined rigidity, in order to be meaningful. A clear definition and agreement of what constitute a failure following endodontic treatment does not exist among endodontist. As like in other medical or dental procedures, the complications may occur during the root canal or endodontic procedure.

Thus, endodontic mishaps are the unfortunate accidental error occurs during the endodontic therapy iatrogenicaly or due to lack of knowledge [3]. Present review of literature aims to discuss endodontics procedural errors in details.

Classification of endodontic mishaps and management [2-6].

Table 1

Related to access opening of the pulp space	Related to canal shaping and cleaning	Related to obturation	Miscellaneous
▪ Treating the wrong tooth ▪ Missed canals ▪ Damage to existing restoration ▪ Perforations ▪ Crown fractures	▪ Ledge formation & canal blockage ▪ Cervical canal perforations ▪ Deviation from normal canal anatomy ▪ Separated instruments ▪ Obstruction by previous obturating materials	▪ Over- or under extended root canal fillings ▪ Nerve paresthesia ▪ Vertical root fractures	▪ Post space perforations ▪ Irrigant related mishaps ▪ Tissue emphysema ▪ Instrument aspiration

Endodontic mishaps related to access opening of the pulp space

1. Treating the wrong tooth

The reason for this mishap results due to incorrect diagnosis of the diseased tooth. And, one should make sure through inquiry, testing, examining, and radiography that which tooth require the treatment. Due to wrong treatment, a patient may suffer the pain continuously and lost the vitality of another healthy tooth. Before starting endodontic procedure, identification of painful or offended tooth is important. After obtaining the valid consent and

permission from the patient, anesthesia should be administered. The management include the treatment of the incorrectly opened tooth as well as treatment of the diseased tooth [7].

2. Perforations

Root perforation is an artificial communication between the root canal system to the supporting tissues of teeth or to the oral cavity. Perforation can be of two types, one that results from a resorptive process and the other, that is iatrogenically produced, which can occur during access cavity preparation and location of canal orifices or biomechanical preparation of the root canal or during a post endodontic procedure. Factors of significance to the prognosis for treatment are time, size, and shape of the perforation as well as its location impacts the potentials to control infection at the perforation site. Frequently, the cause is iatrogenic as a result of the misaligned use of rotary burs amid endodontic access preparation and search for root canal orifices. MTA has been considered as an ideal material for perforation repair, apexification, retrograde filling, pulp capping, etc. MTA is a mineral powder that is made up of hydrophilic particles, whose principal components are dicalcium silicate, tricalcium of slica aluminum and oxide along with other mineral oxides [8]. Main *et al*. took note that MTA gives an ideal repair of tooth perforations and enhanced the prognosis of perforated teeth [9].

3. Missed canal

One of the main causes of endodontic treatment failure is the clinician's inability to localize all the root canals. Due to the complex anatomy of the root canal system, missed canals are not uncommon. There are several strategies to decrease the possibility of missed root canals starting with good pre-operative radiographies. In order to overcome the limitations of conventional radiographies, cone-beam computed tomography (CBCT) can be considered. A correct access cavity preparation is of pivotal importance in localizing the orifices of the root canals. Furthermore, ultrasonics is very important devices to find missed canals. Increasing magnification and illumination enhance the possibility of finding all root canals during root canal treatment [10].

Endodontic mishaps related to canal shaping and cleaning

1. Ledge formation and canal blockage

A ledge is an iatrogenically created irregularity (platform) in the root canal that impedes access of instruments (and in some cases irrigants) to the apex, resulting in insufficient instrumentation and incomplete obturation. Thus, ledges frequently contribute to ongoing periapical pathosis after root canal treatment. Ledging of curved canals is a common instrumentation error that usually occurs on the outer side of the curvature due to exaggerated cutting and careless manipulation during root canal instrumentation. Use of preoperative radiographs for anatomy and working length of the canal, knowledge of the anatomy of teeth, good irrigation of the canal with irrigants, attentiveness of the dentist, can be helpful in the prevention of ledge formation.

2. Separated instruments

Instrument fracture within the root canal during root canal treatment is an unwanted and frustrating complication. The fractured segment may hinder cleaning and shaping procedures with potential impact on prognosis of treatment. Most of the stainless steel instruments fail by excessive torque and NiTi rotary files usually fracture because of torsional stress and cyclic loading. Fractured instrument itself may not cause treatment failure. However, the remaining fragment in the root canal can hinder proper preparation of root canal space [12].

The proper knowledge of the root canal anatomy and clinical practice firstly on models or extracted teeth, avoid the use to excess force in the canal, inspection of instruments, proper use of lubricants and irrigants can be the preventive measures for instruments breakage in the canals. The optimal management of instrument fracture is retrieval of that separated part from the canal, and if it is bind to the dentin with no symptoms it can be bypassed with proper sealing. Ultrasonic instruments are effective in loosening and flushing out broken fragments of the files or reamers [3].

3. Canal blockage

Blockage by dentin chips and/or tissue debris is an obstruction in a previously patent canal that prevents access and complete disinfection of the most apical part of the root canal system. The blocked canal may contain: compacted dentinal mud (most frequently infected); and/or residual pulp tissue; and/or remnants of filling materials (in cases of retreatment) [13].

4. Strip perforation

Strip perforations result from over-preparation and straightening along the inner aspect of the root canal curvature. These midroot perforations are again associated with destruction of the root cementum and irritation of the periodontal ligament and are difficult to seal. The radicular walls to the furcal aspect of roots are often extremely thin and were hence termed ‘danger zones’ [14].

5. Zip

Zipping of a root canal is the result of the tendency of the instrument to straighten inside a curved root canal. This results in over-enlargement of the canal along the outer side of the curvature and under-preparation of the inner aspect of the curvature at the apical end point. The main axis of the root canal is transported, so that it deviates from its original axis. Therefore, the terms straightening, deviation, transportation are also used to describe this type of irregular defect. The terms ‘teardrop’ and ‘hour-glass shape’ are used similarly to describe the resulting shape of the zipped apical part of the root canal [14].

6. Elbow

Creation of an ‘elbow’ is associated with zipping and describes a narrow region of the root canal at the point of maximum curvature as a result of the irregular widening that occurs coronally along the inner aspect and apically along the outer aspect of the curve. The irregular conicity and insufficient taper and flow associated with elbow may jeopardize cleaning and filling the apical part of the root canal [14].

Endodontic mishaps related to obturation

1. Overextended and underextended root canal fillings

The extrusion of the gutta percha cone beyond the apical limit is the overextension whereas in underextended root canal fillings the gutta-percha or any other obturation material is even not able to reach up to its original working length that shorter obturation.

The nerve paresthesia is often the result from the overextension due to overfills. The underextended obturation occurs mainly due to loss of working length as a result of packing dentinal mud into the pulp space without recapitulation or insufficient irrigation, thus copious irrigation is recommended and the radiographs should be taken with gutta percha to confirm the working length of root filling material and, it should be sealed. Whereas, to prevent the overextension use of apical stop is must, proper working length must be taken either with the radiographs or apex locaters.

2. Instrument aspiration

Accidental aspiration or ingestion of foreign bodies is a complication encountered across all age groups. It normally affects pediatric patients or unconscious, mentally ill or disabled people whose coordination or control of deglutition is impaired. Swallowed foreign objects can get lodged in the pharynx, esophagus, stomach, intestine or simply pass through the gastrointestinal tract [3]. Aspirated foreign objects can get lodged in the larynx, trachea or bronchus and is more serious situation with the possibility of suffocating [15]. Susini *et al*. (2007) reported the incidence of aspiration for endodontic instruments was 0.001 per 100,000 root canal treatments and the incidence of ingestion was 0.12 per 100,000 root canal treatments [16].

Once the object gets accidentally swallowed or aspirated, clinician should make every possible effort to locate and retrieve it. Patient should be placed in dependent position and coughing encouraged, thereby expelling it. If upper airway obstruction occurs, immediate steps to establish the airway must be taken. The Heimlich maneuver, back blows in infants, chest or abdominal thrust in obese or pregnant patients should be performed to dislodge the object. Foreign objects lodged in the upper aspect of trachea or esophagus may be retrieved with simple instrumentation such as hemostats, DeBakey forceps, Magill forceps, high-vacuum suction and a laryngoscope. If all these steps are unsuccessful, rapid localization of the foreign body is indicated. In present case, early localization of aspirated endodontic file was made possible by plain chest radiography and computed tomography. Computed tomography provides better contrast and improved three-dimensional localization. A bronchoscopic examination with localization and removal of the object as soon as possible after aspiration is the treatment of choice. The use of fluoroscopy during the bronchoscopic examination is highly recommended [15, 17].

3. Irrigant related mishaps

Sodium Hypochlorite (NaOCl) is a common irrigation solution used in root canal treatment. It has strong antibacterial and tissue dissolving properties. Nevertheless, it has some serious complications, some of which are life-threatening [18].

Sodium hypochlorite accidents are the most commonly caused by loss of working length active irrigation, open apex, fractured root, perforation, presence of lateral canals and fenestration may contribute to extrusion of NaOCl into periradicular area. Sodium hypochlorite accidents mostly occur in buccal and infraorbital region as the apex of teeth lying in these areas may sometimes fenestrate the overlying alveolar bone naturally. Sodium hypochlorite accidents occur more commonly in maxilla than mandible because the roots of maxillary teeth are in close proximity to the labial bone surface [19].

A NaOCl accident can be prevented if the irrigating device used is at least 2 mm short of the working length during irrigation. Delivery of irrigating solution passively with low pressure not only prevents extrusion of NaOCl but also prevents apical extrusion of debris from the root canal. It was observed that binding of syringe within the canal deliver the irrigating solution actively. Use of sidevented needle lowers the risk of accidental extrusion of irrigant into the periapical tissues through the apical foramen [20].

Management of NaOCl accident depends upon the degree of tissue damage and type of tissue involved. During management, NaOCl solution should be interrupted from spreading further into the tissue, thus reducing the tissue damage. During initial 24 hours, cold compressions may be helpful in controlling the swelling with immediate irrigation of root canal or damaged soft tissue with normal saline to dilute the NaOCl. After 24 hours, hot packs may be beneficial in increasing circulation. Analgesic and oral antibiotics should be taken immediately and continued for 7 days to reduce secondary infection. Antibiotics can be further modified according to patient's current condition. Patient is advised for steroid therapy for 2–3 days to control inflammatory reaction. The patient should be kept under observation. Root canal treatment(s) can be deferred until the symptoms subside [20, 21].

Conclusion

Endodontic failure still occurs despite technological advancements in the field of dental instrumentation and materials. Lack of scientific knowledge, its poor application, or a compromise or a break in the chain of proper measures can lead to a number of accidents which are collectively called 'endodontic mishaps'. With improved magnification by operating microscope, direct lighting, use of ultrasonics, NiTi instruments, multiple delivery systems for obturation, almost all procedural errors during endodontic therapy can be minimized or prevented/ successfully treated with predictable prognosis.

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